Strategic Intellectual Property Rights Policy and North-South Technology Transfer

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Summary

This paper analyzes welfare implications of protecting intellectual property rights (IPR) in the framework of TRIPS for developing countries (South) through its impact on innovation, market structure and technology transfer. In a North-South trade environment, the South sets its IPR policy strategically to manipulate multinationals' decisions on innovation and location. Firms can protect their technology by exporting or risk spillovers by undertaking FDI to avoid tariffs. A stringent IPR regime is always optimal for the South as it triggers technology transfer by inducing FDI in less R&D-intensive industries and stimulates innovation by pushing multinationals to deter entry in high-technology sectors.

Keywords: Intellectual property rights, Technology transfer, Multinational firms, Foreign direct investment, North-South trade

JEL Classification: O34, F23, F13, L13, O32, L11, O38

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1. Introduction

Protection of intellectual property rights (IPR) has been an issue of rising interest in both industrialized and developing countries (South). The controversies tend to center on the relatively new Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement of the Uruguay round of GATT, which has called for a standardization of IPR protection among all members of the World Trade Organization (WTO) and potential new entrants. It requires developing countries to raise their intellectual property protection level to the standard in force in industrialized nations at the time of negotiation.[1] The agreement was a consequence of complaints and lobbying undertaken by technology intensive firms in the North claiming to have lost billions of dollars through infringement of their property rights due to loose IPR protection regimes in the South. These firms urged the WTO to bring this issue into the ambit of GATT, arguing that weak IPR protection lowers trade volume, distorts trading patterns, and deters firms from transferring technology abroad. Developing countries have however continuously resisted adopting stronger IPR legislation and its enforcement with the fear that foreign interests would be the only beneficiaries of such policies at the expense of domestic consumers. A question often asked is whether such behavior is rational when it has a direct effect on the behavior of multinationals and if it could be justified in terms of welfare.

The literature on IPR has been shifting back and forth from those against protecting IPR to others in its favor. In the early 1990s theoretical economists highlighted the negative consequences of such policies for the South. They showed the static welfare effects of IPR protection by examining the trade-off between the incentives it creates to innovate and the monopoly market

[1] TRIPS does however offer flexibility for developing countries and economies in transition. They are granted a four-year transition period (10 years for least developed countries extendible upon request) to adapt to the required obligations with an additional five years for technology-oriented product patents not protected at the date of agreement (Braga, et al., 2000).

power it yields to innovators. Chin and Grossman (1990) and Deardorff (1992) clearly displayed these trade-offs in a static welfare analysis. Both papers showed that the North always wins and the South generally loses when the latter adopts a patent policy from the North. Zigic (1998) extended this model to allow for different levels of IPR protection and found that while this conflict holds when R&D efficiency is low, the interests could actually be in congruence for moderate and high R&D efficiency levels. Similar to Chin and Grossman (1990), it used a two-stage game with an exogenous IPR policy, where the Northern firm chooses the optimal level of R&D in the first stage and competes with a Southern firm in the second stage. It should be kept in mind however that recent examples in the world such as the refusal by South Africa to abide by the TRIPS agreement with regard to pharmaceutical drugs have shown that governments in the South do possess the authority to choose their IPR regime.

A sharp rise in international investments in the 90's and a remarkable increase in the degree of IPR protection in the same period has nonetheless raised inquisitiveness about the link between technology transfer and IPR protection (Maskus, 1998). This led the IPR literature to a turn in favor of IPR protection by analyzing firms' decisions on the form and the amount of technology transfer to the South. Helpman (1993), Lai (1998), and Yang and Maskus (2001) were among these papers and used endogenous growth models to show that protecting IPR *could* benefit the South by increasing the flow of technology to the South.[2] This branch of the IPR literature has

[2] The first basic model of this was introduced in the last section of Helpman (1993) to include FDI. It was shown that with exogenous innovation, FDI rises with a tightening of Southern IPR protection. Lai (1998) extended the model to show that when FDI is the channel of transfer, the rate of innovation also increases along with the rate of FDI as a result of a tighter IPR protection policy. Yang and Maskus (2001) showed that when the channel of diffusion is licensing, both rates of innovation and technology transfer increase due to lower transfer costs and less rent sacrifice for the licensor to prevent possible imitation by the licensee.

focused on the consequences of IPR protection on the rate of innovation and the rate of FDI leaving room for more work to be done on issues involving welfare.

In the last couple of years attention has once again been focused on the welfare implications of TRIPS and the literature has again turned against globally harmonized IPR standards. Recent interesting work by Grossman and Lai (2002) for example shows the adverse effects of IPR protection for the South in a trade environment.[3] The paper uses a rich model to derive the welfare implications, but similar to the skeptical literature of the early 1990's it abstracts from the role of FDI and technology transfer in the analysis.[4] Concerns over FDI and technology transfer should be taken into account while analyzing welfare, as they can be the only means of enhancing growth and prosperity in many least developed countries.

The model presented in this paper takes a step further and present a welfare analysis explicitly for the South that embodies the consequences of the Southern IPR policy on foreign investment, market structure and innovation. It endogenizes Southern IPR policy and the Northern firm's decision on whether to serve the Southern market through exports to obstruct exposure of its technology or by engaging in FDI to avoid trade costs. The latter option could cause a spillover of its innovative technology to the Southern firm, the level of which is determined by the IPR regime in the South. The Northern firm can still deter entry after relocation by choosing the exact level of R&D investment that makes it unprofitable for the Southern firm to produce. Shedding light on these missing points in the strategic IPR literature, this paper overturns the results attained in the existing literature and shows that the South can always gain from enforcing a

[3] This paper applies patent length as opposed to the level of spillover as an indicator of IPR protection.

[4] Recent empirical work by McCalmen (2001) also suggests that the South has been worse off with the TRIPS agreement using the resulting transfers of income from the South to the North as evidence. Gains from FDI and technology transfer are also absent in his analysis.

stringent IPR regime in terms of welfare, either by attracting foreign investment in less R&D intensive industries or by simulating innovation in high technology sectors.

The game takes place in five stages. In the first stage, the Southern government sets the optimal IPR protection level strategically. In the second stage, the Northern firm decides its mode of supply, namely whether to export or to move production to the South. The South chooses its tariff policy in the third stage. The Northern firm then invests in R&D in accordance with its decision from the second stage and finally firms engage in production. The timing is chosen in this manner in order to specifically reflect the power of the TRIPS agreement. It shows how TRIPS is capable of eliminating moral hazard problems that could occur if the IPR policy is left flexible to be set at a later stage. That is to say once in the WTO (and hence a signatory of TRIPS), a government has the credibility to commit to its IPR policy before firms make their choices.

The rest of this paper is structured as follows: section 2 presents the basics of the model following Chin and Grossman (1990) and Zigic (1998) and briefly examines the final production stage of the game. Section 3 introduces the options faced by the Northern firm regarding the supply mode. It then calculates the optimal R&D investment for each case and discusses the multinationalization decision of the Northern firm. Section 4 finds the optimal IPR regime for the South and reveals the equilibrium market outcome. Finally, section 5 concludes the paper.

2. The Model

2.1. Assumptions

There are two countries, the North and the South, with one firm residing in each country. Firms produce a single homogeneous good. A familiar linear inverse demand (market clearing price) $P=A-Q$ is used where A represents the size of the market and Q the total quantity produced by the North and the South: $Q=q_n+q_s$. As our market of interest is the South here, only goods targeted particularly at the Southern market are considered. Alternatively, a segmented market framework can be used in which the Northern firm produces for both markets, but perceives the two markets to be different; therefore, its optimization problem for the Southern market is independent of that

for its domestic market. This is also known as differential pricing, which is an economically rational way for multinationals to maximize their profits on products that are sold in both low and high income markets.[5] Southern consumer surplus is then simply the area under the demand curve:

$$S = \frac{(q_n + q_s)^2}{2}. \quad (1)$$

On the supply side, the Southern firm is assumed to be incapable of acquiring the *production* technology unless the Northern firm moves production to the South (or so to say the technology restriction is "binding" when market is served through arm's length).[6] In other words, the Northern firm acquires a monopoly position by producing at home. If the Northern firm chooses to move production to the South, the Southern firm can enter the market and the two firms compete in a Cournot duopoly setting. Furthermore, the Northern firm is capable of engaging in R&D aimed at innovating more cost-effective production technologies.[7] Knowledge gained through R&D is however assumed to have a public good character and can be imitated at zero cost. The unit cost function for the Northern and the Southern firm is respectively

$$C = \alpha - (gx)^{1/2}, \quad (2)$$

[5] A good example of this is the pharmaceutical industry and medicine for AIDS. Being forced to reduce prices of their products for consumption in developing countries, pharmaceutical firms now engage in price differentiation. Arbitrage is prohibited through a ban on parallel importing of medicines into the US and the EU to assure segmented markets. See Maskus (2000a).

[6] As the paper focuses on process innovation (patent of technology) rather than product imitation (copyrights, trademarks), it does not consider cases where the importance of R&D is negligible and no unique key technology is required to produce the good. An example of the latter is the CD or the apparel industry where imitation (pirating, reproduction) can easily take place even when goods are imported.

[7] This assumption can be justified by the fact that less than 1% of existing patents are held by developing countries (See appendix C in Zigic (2000) for the R&D expenditures statistics of the North and the South).

$$c = \alpha - \beta(gx)^{1/2}, \tag{3}$$

where $x \leq \alpha^2/g$, $A > \alpha$, and $0 \leq \beta \leq 1$; x is the cost-reducing R&D investment, parameter α reflects pre-innovative basic unit costs, β is a measure of IPR protection in the South and determines the degree of spillovers (with $\beta=0$ reflecting full protection/no spillover and $\beta=1$ no protection/full spillover), and g is the efficiency of the R&D process. Note that R&D reduces the unit cost of production at a diminishing rate.

The timing of the game is illustrated in figure 1, where actions by the Northern firm are shown in white and those of the South are specified with shaded boxes. The next section briefly explains the fifth stage of the game, namely the production stage, where the firms compete in quantity.

2.2. Production

The Northern firm maximizes its profits, which consists of operating profits less the research expenditure and in the case of exports less the total tariff costs:

$$\underset{q_n}{Max}\, \pi_n(x) = [A - (q_n + q_s)]q_n - Cq_n - tq_n - x. \tag{4}$$

The profits of the Southern firm on the other hand are zero if the Northern firm stays at home, or simply its operating profits in the FDI duopoly case. The latter gives the maximization problem of

$$\underset{q_s}{Max}\, \pi_s(x) = [A - (q_n + q_s)]q_s - cq_s. \tag{5}$$

The optimal quantity produced by the Northern firm for exports is derived from the first order condition of (4) with respect to q_n, while setting q_s to zero due to the monopoly position to get

$$q_{nm}^*(x) = \frac{A - \alpha + (gx)^{1/2} - t}{2}. \tag{6}$$

Subscript m denotes monopoly exporting. If FDI is the outcome, firms engage in competition and maximize profits with $t=0$. The optimal quantities produced by each firm under duopoly are

$$q_{nf}^*(x) = \frac{A - \alpha + (2 - \beta)(gx)^{1/2}}{3} \quad \text{and} \quad q_{sf}^*(x) = \frac{A - \alpha - (1 - 2\beta)(gx)^{1/2}}{3} \tag{7}$$

for the Northern and the Southern firm respectively where subscript f stands for FDI. The optimal

R&D investment and profits are found for exports and FDI in the next section, where the Northern firm compares profits to decide how to serve the Southern market.

3. Northern firm's Multinationalization Problem

3.1 Export

If the Northern firm is highly concerned about the infringement of its technology, it could decide to keep production in the North and export the final good to the South. This serves as an indirect protective act by the Northern firm to avoid the imitation of its technology. Exporting rather than moving production to the South as a response to weak IPR protection is confirmed by Smarzynska (1999) who provides empirical evidence that the latter deters foreign investors from undertaking local production and shifts them towards distribution of imported products.

While saving its technology from being imitated, exporting incurs extra trade costs for the Northern firm. The only other IPR-related strategic literature to our knowledge that relates tariffs to IPR is Zigic (2000). The paper introduces strategic trade policy into the IPR context; however, it only focuses on Northern welfare and leaves out the implications for the South. A punitive tariff is imposed on goods exported back to the North to deal with the violation of property rights in the South. In the model in hand by contrast, tariffs serve the purpose of making the problem a trade-off between trade costs savings and losses caused by imitation.

As was already indicated, if goods rather than the technology are imported, it is assumed to be too costly and therefore impracticable for the South to invent around the patent as it is in the possession of no R&D resources (see section 2). The optimal R&D investment in this case can be found from the first order condition of (4) with respect to x, using q_{nm}^* as the monopoly output:[8]

[8] In order to simplify the notation in the upcoming equations, unit tariff rate t is normalized by the size of the market and referred to it as $0 \leq \tau \leq 1$ to get $t=\tau(A-\alpha)$. This allows us to set $(A-\alpha)$ to unity as $(A-\alpha)^2$ appears in all relevant equations.

$$x_m^*(\tau) = \frac{g(1-\tau)^2}{(4-g)^2} \tag{8}$$

where τ is the normalized tariff rate. It can be seen in (8) that, given g, R&D expenditure x_m is always falling in τ. Substituting (6) and (8) into (4), optimal Northern export profits can be derived:

$$\pi_{nm}^*(\tau) = \frac{(1-\tau)^2}{4-g}. \tag{9}$$

Notice that as there is no exposure to imitation, Northern profits are independent of the Southern IPR regime β. Profits clearly fall with a higher tariff rate.

In the third stage, which is only relevant if the Northern firm decides to export, the Southern government chooses an optimal tariff that maximizes Southern welfare under exports W_m.[9] Welfare consists of Southern consumer surplus under exports S_m and tariff revenue T that comes from a unit tax levied on all imported good. The problem for the South is

$$\underset{t}{Max}\, W_m = S_m + T, \tag{10}$$

where S_m is found by replacing the anticipated monopoly quantity produced by the North[10] in (1) giving

$$S_m = \frac{2(1-\tau)^2}{(4-g)^2}. \tag{11}$$

[9] The timing of the trade policy reflects the fact that tariffs are legally left more flexible by the WTO for antidumping measures. The opposite holds for IPR protection in the presence of TRIPS, as it can by no means be used as an instrument for reciprocal action against tariffs or any other policy. It also prevents the government in the South from enjoying a free holiday in the absence of the TRIPS agreement by first bringing in firms through high tariffs and then exploiting their technologies through loose IPR policies. In this case, a Northern firm can of course also decide not to serve the host country and pull out of its market.

[10] Only the final forms of S_m, T, and τ are shown using the optimal R&D investment x_m^* from equation (8).

Consumers always lose when the tariff rate τ increases as both the quantity produced and the R&D expenditure fall with increasing τ. Yet, the South has tariff revenue T as another source of income which is solved for using q_{nm}* as the quantity imported:

$$T = tq_{nm}^* = \frac{2\tau(1-\tau)}{(4-g)}. \tag{12}$$

Tariff revenue increases directly with increasing τ and falls indirectly due to the cut back in production caused by a higher τ. T reaches its maximum level at $\tau = 0.5$. The first order condition of W_m with respect to τ gives the optimal tariff τ* in terms of g:

$$\tau^* = \begin{cases} \dfrac{2-g}{2(3-g)} & for \quad g \le 2 \\ 0 & for \quad g > 2 \end{cases} \tag{13}$$

When g is zero, the optimal tariff is at its highest value of *1/3* as the tariff revenue portion of welfare dominates consumer surplus in less R&D intensive industries. The optimal tariff decreases as g increases until it reaches zero at $g=2$. Free trade is the optimal trade policy for high R&D efficiency levels of $g \geq 2$.[11]

Substituting the optimal tariff for τ in (9) we can now derive the optimal profits of the Northern firm in case of exports:

$$\pi_{nm}^* = \begin{cases} \dfrac{4-g}{4(3-g)^2} & for \quad g \le 2 \\ \dfrac{1}{4-g} & for \quad g > 2 \end{cases} \tag{14}$$

[11] Another way to bring trade policy into the model is to treat tariffs as exogenous. The notion of the results remains the same. For $0 < g \leq 1.5$ the optimal FDI inducing level of IPR protection decreases with higher tariffs and to a lesser extent the higher is R&D efficiency. Also for more R&D intensive industries of $g>1.5$ the outcome is the same as the desire for innovation is the decisive factor in determining the IPR policy.

Notice that the Northern firm chooses between exporting and FDI by anticipating τ^*.[12] The optimal tariff is set to maximize national welfare in the South and tariffs above this level are never chosen as they only reduce Southern welfare.

The next section discusses the FDI alternative, which the Northern firm must compare with the export option to decide how to serve the Southern market.

3.2 FDI

Avoiding trade and transport costs is one of many motives for the Northern firm to establish local subsidiaries to serve its foreign markets. This paper looks at FDI as a way to save on trade-costs, which must be weighed against the losses from imitation that could follow the relocation of production.[13] In most developing countries, access to technology occurs mainly by means of FDI channels of diffusion rather than through domestic innovation.[14] Once production is moved to the South, basic production technology can be gained. When patents are binding however, the cost-reducing technology instigated by Northern R&D is not fully exposed to the South. A looser IPR regime allows more know-how to be disclosed to the Southern firm and lowers the costs of production for the latter.

The Southern firm then competes to serve the market if profitable. This creates an asymmetric duopoly situation (except when $\beta=1$) due to cost asymmetries resulting from the enforcement of IPR. In other words, IPR protection prevents the Southern firm from fully utilizing the cost-reducing R&D invented by the Northern firm. The optimal R&D investment is found from the first order condition of the Northern firm's profit function using (7) to replace for output:

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[12] The Northern firm is fully aware of the optimal tariff rate, and tariff rates other than τ^* are not credible.

[13] Fixed FDI costs are left out while solving the model. Adding fixed costs would only reinforce the results by linearly decreasing FDI profits. This makes exporting more attractive and decreases the maximum β at which the Northern firm would undertake FDI.

[14] See Commission on Intellectual Property Rights (2002).

$$x_f^* = \frac{g(2-\beta)^2}{\left[9-g(2-\beta)^2\right]^2}. \tag{15}$$

It is easy to see that R&D is lower for looser levels of IPR protection as $\frac{\partial x_f^*}{\partial \beta} < 0$. The optimal profits for the Northern firm in an FDI duopoly situation are obtained by replacing (7) and (15) into the profit function (4) to get:

$$\pi_{nf}^* = \frac{1}{9-g(2-\beta)^2}. \tag{16}$$

Equation (16) shows that except for *g=0* where no R&D takes place, Northern profits are always falling in β. The β at which FDI profits intersect export profits can be found by setting (14) equal to (16) and solving for β:

$$\beta^* = 2 - \sqrt{\frac{15-4g}{4-g}} \tag{17}$$

Equation (17) implies that if the level of IPR protection in the South is high enough ($\beta < \beta^*$) so that the Northern firm's losses from spillovers are not drastic, it chooses FDI as the mode of supplying the Southern market. However for looser IPR regimes ($\beta > \beta^*$), it keeps production in the North to protect the dissemination of its technology. $\beta^* = 0.064$ when g is zero and increases with R&D efficiency as the impact of the latter on profits is much stronger at lower β's, where the Northern firm can take full advantage of its own R&D. The rise in β^* is however relatively small as the optimal tariff rate decreases with a higher g at the same time making exports more attractive. β^* eventually reaches its highest level, which is only *0.129*, when *g=2*.

Once FDI has been carried out, profits of the Southern firm in a duopoly are

$$\pi_{sf}^* = \frac{\left[3-g(1-\beta)(2-\beta)\right]^2}{\left[9-g(2-\beta)^2\right]^2} \tag{18}$$

Southern profits are increasing in β as higher spillovers lead to lower production costs. Setting expression (18) to zero helps us derive the critical value of β for each g under which it is no longer profitable for the Southern firm to enter the market:

$$\hat{\beta} = \frac{3 - \sqrt{1 + 12/g}}{2} \tag{19}$$

$\hat{\beta}$ is zero for $g=1.5$ and increases thereafter as a higher R&D intensity makes it more difficult for the Southern firm to compete in the market. At lower efficiency levels of R&D ($g < 1.5$), it is always profitable for the Southern firm to enter the market.

If the Northern firm finds it optimal to deter entry to the market, it can attain a constrained monopoly position by choosing a predatory level of R&D that makes it unprofitable for the Southern firm to produce and compete. Setting q_{sf} in (7) equal to zero and solving for x,

$$x_p^* = \frac{1}{g(1-2\beta)^2} \tag{20}$$

is the R&D investment where strategic predation is adopted with p denoting predation.[15] The predatory level of R&D is much higher than that under FDI duopoly or export. This makes strategic predation a profitable option only when the efficiency of R&D is high enough and if the firm's technology is highly protected. In contrast to the duopoly case, here R&D investment increases with higher imitation, i.e. lower IPR protection levels. Zigic (1998) interpreted this perverse result as a need for higher R&D efforts to force the Southern firm out of the market when there are higher spillovers since the gap between the Northern and Southern unit costs is smaller. Profits of the Northern firm when it deters entry to the market is

$$\pi_{np}^* = \frac{g(1-\beta)^2 - 1}{g(1-2\beta)^2}. \tag{21}$$

[15] The optimal R&D investment levels under FDI are similar to those obtained in Zigic (1998) in the case of duopoly and strategic predation.

Strategic predation profits are decreasing in β for $g \leq 2$. Comparing (16) and (21) yields $\pi_{nf}^* \geq \pi_{np}^*$ showing that the Northern firm unconditionally prefers to engage in duopoly when the latter is a possible outcome. Profits with strategic predation are only equal to duopoly profits at $\hat{\beta}$ for $g \geq 1.5$, which is exactly the point where the Southern firm exits the market and duopoly is no longer viable.

3.3 The Multinationalization Decision and Market Structure

With duopoly as the preferred market structure under FDI, the problem of the firm for $g<1.5$ is simply to observe the IPR regime in the South and use β^* to decide between securing a monopoly position by exporting or engaging in duopoly by undertaking FDI.

For $g \geq 1.5$ on the other hand, the value of β determines the market structure under FDI. When $\beta \leq \hat{\beta}$, strategic predation is the only alternative to exports as duopoly is not a feasible option. Hence, in order to choose the mode of supply the firm compares export profits to (21). The critical level of IPR protection that makes profit under exports equal to that with predation is

$$\beta^{**} = \frac{g(2-g)(7-2g) - (3-g)\sqrt{g(2-g)(10-3g)}}{2g(g^2 - 5g + 5)} \tag{22}$$

FDI is chosen and followed by strategic predation for $\beta < \beta^{**}$, whereas a higher β provokes the Northern firm to export. For $\beta > \hat{\beta}$ where duopoly is feasible, it is the preferred form of the market under FDI as long as $\beta < \beta^*$ after which exporting dominates.

Figure 2 illustrates how the Northern firm makes its choice on the mode of supply and the market structure using two variables: the R&D efficiency parameter, and the IPR policy set by the Southern government in the first stage. Notice that for $1.5 \leq g < 1.81$, β^{**} lies above the predation region implying that when FDI with strategic predation is feasible, it always dominates the export option. In this case $\hat{\beta}$ determines the market structure under FDI, while β^* is the dividing line between FDI and exports. For $g \geq 1.81$ on the other hand, β^* falls below $\hat{\beta}$

indicating that duopoly is never chosen when it is an option as exporting always brings higher profits. For this range of g, β^{**} is the only binding threshold value of IPR protection that separates the decision between exporting and FDI.

Proposition 1

For $0 < g \leq 1.81$, the Northern firm protects its technology by choosing to export when $\beta > \beta^*$ and undertakes FDI for more stringent IPR regimes of $\beta < \beta^*$. Once FDI is carried out, it deters entry to the market if $\beta \leq \hat{\beta}$. For more technology intensive industries of $1.81 \leq g \leq 2$, FDI is always accompanied by entry deterrence and only preferred to exports when $\beta < \beta^{**}$.

We now turn to section 4 to show how the Southern government can strategically act to bias the multinationalization decision of the Northern firm in its own favor.

4. IPR Policy in the South

In the first stage of the game, the Southern government maximizes welfare by choosing an optimal level of IPR protection strategically. The policy is endogenous in the model unlike previous literature in the sense that the government takes the Northern firm's reaction into consideration when choosing its IPR regime. The Northern firm hence is not the sole force to determine the market structure with the Southern government now able to influence the latter.

When the Northern firm engages in FDI, Southern welfare consists of consumer surplus, plus the profits of the Southern firm in case of duopoly:

$$W_f = \begin{cases} S_f + \pi_{sf} & for \quad duopoly \\ S_p & for \quad strategic\ predation \end{cases} \tag{23}$$

Consumer surplus can be calculated for each scenario under FDI by substituting the corresponding outputs back into (1). This is shown in equations (24) and (25) for duopoly and strategic predation respectively:

$$S_f = \frac{[6 - g(2-\beta)(1-\beta)]^2}{2\left[9 - g(2-\beta)^2\right]^2}, \tag{24}$$

$$S_p = \frac{(1-\beta)^2}{2(1-2\beta)^2}. \tag{25}$$

As duopoly was shown to be the only possible market outcome under FDI for $g<1.5$, the sum of (18) and (24) determines Southern welfare for this range of g. $\frac{\partial S_f}{\partial \beta} < 0$ suggests that, unlike Southern profits, consumer surplus in the South falls with looser IPR protection when duopoly is the prevailing form of competition. This is directly related to the Northern firm investing less in R&D and producing less as β increases. The Southern firm's profit and thus the desire for imitation dominates Southern welfare at low g's causing it to rise with a higher β. As R&D intensity increases though, the magnitude of the loss in consumer surplus caused by a higher β increases, giving innovation more significance in Southern welfare.

Things differ for $g>1.5$ as strategic predation is a feasible outcome for $\beta \le \hat{\beta}$. Since $\frac{\partial S_p}{\partial \beta} > 0$, consumer surplus and hence welfare always increase with looser IPR protection as the latter raises R&D efforts. The threshold value of β where the Southern consumers are indifferent between duopoly and strategic predation is $\hat{\beta}$ where the R&D investment and consumer surplus are at their maximum level. It is the highest possible β at which the Northern firm adopts strategic predation (highest consumer surplus under strategic predation), and at the same time the lowest β under duopoly that just drives Southern profits to zero (highest consumer surplus under duopoly). It can be seen in (24) and (25) that the same $\hat{\beta}$ makes S_f and S_p and hence W_f and W_p equal. We are now in a position to solve the model for the optimal level of IPR protection from a Southern perspective for different levels of R&D efficiency.

4.1 Low R&D Efficiency

Comparing welfare in the case of exports with that under FDI for $g < 1.5$, it can be seen that the South is always better off with FDI as $W_f > W_m$ for all values of g. The welfare maximizing

Southern government is therefore forced to play strategically to bring FDI into the country. As the Northern firm makes a credible threat of exporting rather than undertaking FDI if the IPR protection level in the South is weaker than β^* *($\beta > \beta^*$)*, the Southern government foregoes its first-best welfare maximizing IPR protection level under FDI to motivate technology transfer. It chooses the lowest level of protection at which the North is still persuaded to engage in FDI rather than exporting to the South, namely β^*.

A higher β brings FDI profits below export profits and hence provokes the Northern firm to keep production in the North. As the South always prefers FDI, it gains from this strategic move even if the IPR protection level required to achieve the transfer of technology is very high. The optimal IPR protection level β^* starts at approximately *0.06* for values of *g* just over zero and increases at a slow rate to only *0.1* as *g* gets near *1.5*.

This can be seen in figure 3 where Southern welfare is illustrated for FDI with the optimal IPR regime, and for exports, the optimal tariff rate in effect. The results for less R&D intensive industries are the opposite to those in previous strategic IPR models in which the absence of legitimate measures to transfer technology led the South to always lose from IPR protection.

Proposition 2: *In less R&D intensive industries ($0<g<1.5$), the South always chooses a stringent IPR protection regime to induce foreign investment as a channel of technology transfer. The optimal level of IPR protection is β^* in this range and is the weakest IPR regime under which the Northern firm still chooses to proceed with FDI.*

4.2 High R&D Efficiency

In relatively more technology intensive sectors of $g \geq 1.5$, entry deterrence is the only feasible market structure under FDI for $\beta \leq \hat{\beta}$ as the Southern firm does not find it profitable to enter the market. As $W_p > W_m$ always holds, Southern welfare with FDI dominates welfare under exports even when strategic predation is adopted. In fact, $W_p > W_f$ shows that for $\beta > \hat{\beta}$ where duopoly is feasible, the South always prefers constrained monopoly to duopoly under FDI. This is due to

the large amount of innovation that takes place by the Northern firm in the case of strategic predation as an attempt to block entry to the market. This is opposite to Northern interests because for $\beta > \hat{\beta}$ it is always more profitable for the Northern firm to compete in a duopoly environment than to deter entry. The South therefore never sets the protection level above $\hat{\beta}$ for duopoly to be a viable choice. We can conclude that the optimal IPR regime in this range of *g* is set to stimulate innovation by inducing strategic predation.

Since W_p is increasing in β, and $\hat{\beta}$ is the lowest level of protection where strategic predation is a possible outcome, $\hat{\beta}$ is the most favorable IPR regime for the South. For $g \leq 1.81$, the Southern government can choose $\hat{\beta}$ to induce strategic predation as opposed to the duopoly form of FDI as $\hat{\beta} < \beta^{**}$ in this region. The latter inequality implies that Northern FDI profits at $\hat{\beta}$ exceed its profits under the export option. For $g > 1.81$ on the other hand, the Northern firm would export if the South continues to use $\hat{\beta}$ as its protection regime because $\hat{\beta} > \beta^{**}$ at such high levels of R&D efficiency. As a result, the South is forced to increase protection up to the threshold value β^{**}, where the Northern firm's profits with strategic predation are equal to the profits it would earn under exports.

The optimal level of IPR protection for $1.5 \leq g \leq 1.81$ is $\hat{\beta}$ and starts at *0* with $g=1.5$ and rises to about *0.11* where it reaches its peak at $g=1.81$. At this point the optimal policy switches to β^{**} and falls in *g* to match the export profits, which are more attractive in this range of *g* due to τ^* getting closer to zero. Ultimately β^{**} reaches zero at $g=2$ where full protection is the only alternative to make the Northern firm content with strategic predation.

The right hand portion of figure 3 shows Southern welfare under predatory FDI using the appropriate optimal level of IPR protection for each range of *g*. It can be seen that welfare is always higher when strategic predation is induced. This is due to the higher innovation activity

that takes place to deter entry to the market, which proves to be the motivation for protecting IPR in more technology intensive sectors.

Proposition 3: *In more technology intensive industries ($1.5 \leq g < 2$) the South always chooses a strict IPR protection regime to stimulate innovation by encouraging the Northern firm to engage in a predatory level of R&D. $\hat{\beta}$ is the optimal IPR protection policy for $g \leq 1.81$ as it is the highest β that suffices to induce FDI over exports, and strategic predation over duopoly. A higher level of protection β^{**} is required to motivate predatory FDI over exports for $g > 1.81$ as exports become more attractive when R&D intensity increases.*

It is helpful to look at figures 2 and 3 simultaneously to see that setting a β above the β^* curve in figure 2 makes Southern welfare in figure 3 jump from the FDI curve to the export curve. Choosing a β below β^* on the other hand slightly shifts the FDI welfare curve downward, while it always remains above the export curve. For a direct comparison of the model with Chin and Grossman (1990), the range of policy set by the North can be restricted to the two choices of $\beta=0$ and $\beta=1$. The South would never strictly prefer no protection to full protection in the presence of technology transfer.

Very high R&D efficiency levels of $g > 2$ resemble results obtained in Zigic (1998). As $\hat{\beta} > \beta^{**}$ in this region, duopoly is never a viable outcome and strategic predation profits never exceed export profits at the now optimal free trade policy. Only at a knife-edge case of $\tilde{\beta} = 1 - 2/g$ profits under strategic predation match what the Northern firm would earn by exporting. Any policy slightly stricter or weaker than $\tilde{\beta}$ leads the Northern firm to export. The South is itself indifferent between strategic predation and monopoly export at $\tilde{\beta}$ as welfare is similar under both market structures. It can be concluded that in industries where R&D plays a vital role, a firm would never risk moving its facilities to the South regardless of the prevailing level of IPR protection there.

5. Conclusion

This paper uses the welfare implications of protecting IPR in developing countries to show that when technology transfer considerations are accounted for, it is not rational for governments in these countries to oppose IPR protection. It attempts to build a more complete model to encompass the credibility aspect of the TRIPS agreement and include other important IPR-related factors next to innovation such as FDI and trade policy. As the Southern government sets the IPR protection level before the Northern firm makes its multinational decision, it can influence this choice by inducing technology transfer or encouraging innovation. In relatively low technology intensive industries, attracting foreign investment as a channel of technology transfer is the motive behind protecting IPR. The level of protection is chosen such that exporting is never strictly preferred to FDI by the North. Although the South may desire a lower level of IPR protection to reach its first-best welfare, the Northern firm's credible threat of exporting rather than undertaking FDI restricts the latter to a stricter IPR regime. This new contribution to the strategic IPR literature shows that even at low levels of R&D efficiency the interests of the North and the South can be in congruence simply because of the Southern need for foreign investment.

For more R&D intensive industries, innovation as opposed to technology transfer is the key concern for protecting IPR in the South. The South stimulates innovation by tempting the multinational to deter entry by means of substantial R&D efforts. Although the South does not imitate the complex technology to compete with the North, it benefits from the enhanced innovation it induces by protecting the IPR of the Northern multinational. Therefore a rational South would never strictly prefer to violate international IPR, as the optimal level of protection for the South is always very high. Endogenizing the decisions of both sides highlights the need for IPR protection in the South if it were to enjoy sufficient levels of foreign investment and innovation.

A possible extension of the model could be to follow the argument in Glass and Saggi (2002) and make imitation costly. This requires the Southern firm to engage in imitation R&D to be able to

utilize Northern innovation R&D. The Southern firm then undertakes own R&D activity, even in the absence of an IPR protection policy, to be able to take advantage of the cost-reducing technology of the competing firm. This setting could describe emerging markets with limited R&D capacity as opposed to less developed countries incapable of engaging in any R&D activity. Another interesting line of research would be to examine the decision of multinationals once they decide to transfer their technology to the South. This could for instance be a choice between FDI or licensing, each of which involve different levels of spillovers. This can also be extended to allow for the entry of more Southern firms into the market once the Northern firm has transferred its know-how. In a multi-firm framework, two firms could for instance engage in a JV to conceal their technology from outsider Southern firms.

It is worth mentioning that this paper only considers the indirect trade impact of IPR protection for the South. Direct trade impacts are not considered as this model assumes that the Northern firm always serves the Southern market as long as there is demand, and has only to choose the channel of transfer. [16] It also ignores other important criteria that may reinforce or rule out the suitability for inclusion of IPR in the WTO such as international externalities, policy coordination failures, and meaningful dispute resolution. Analyzing these criteria shows that IPR may indeed have a stronger case for standardization than other fields such as competition policy, environmental protection, and labor standards (Maskus, 2000b). This paper attempts to make obvious the important role that policy choices of governments in the South play in their welfare when confronting a profit-maximizing multinational whose profits and therefore actions are directly based on these policies. It shows that multinationals have the power to avoid global dissemination of their technology. Therefore nations seeking to gain access to new technologies or simply to a larger amount of the commodities containing them must pay the cost and protect IPR in order to promote growth by inducing FDI and creating the incentives to innovate.

[16] Maskus and Penubarti (1995) uses empirical evidence to demonstrate that IPR are strongly trade-related.

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Figure 1: The Stages of the Game

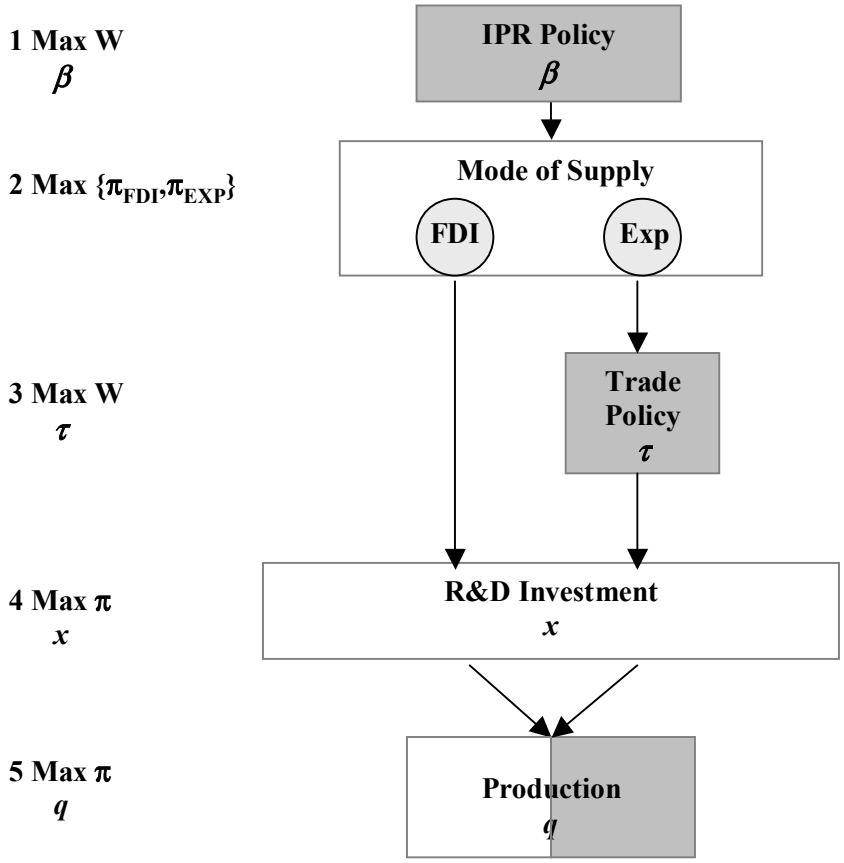


Figure 2:Northern Firm's Multinationalization Decision

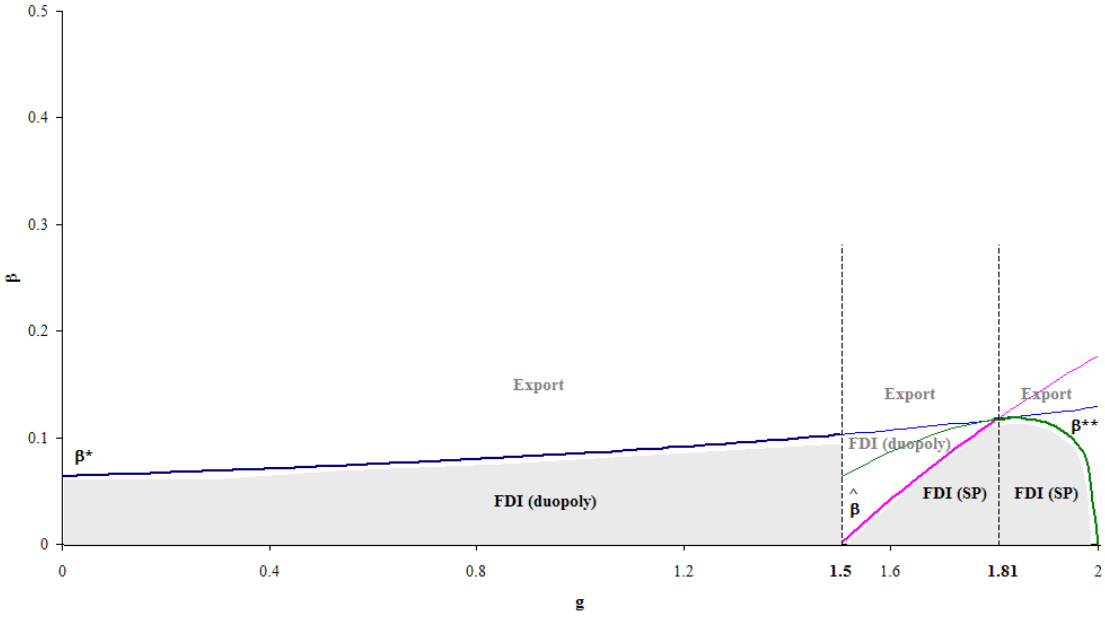
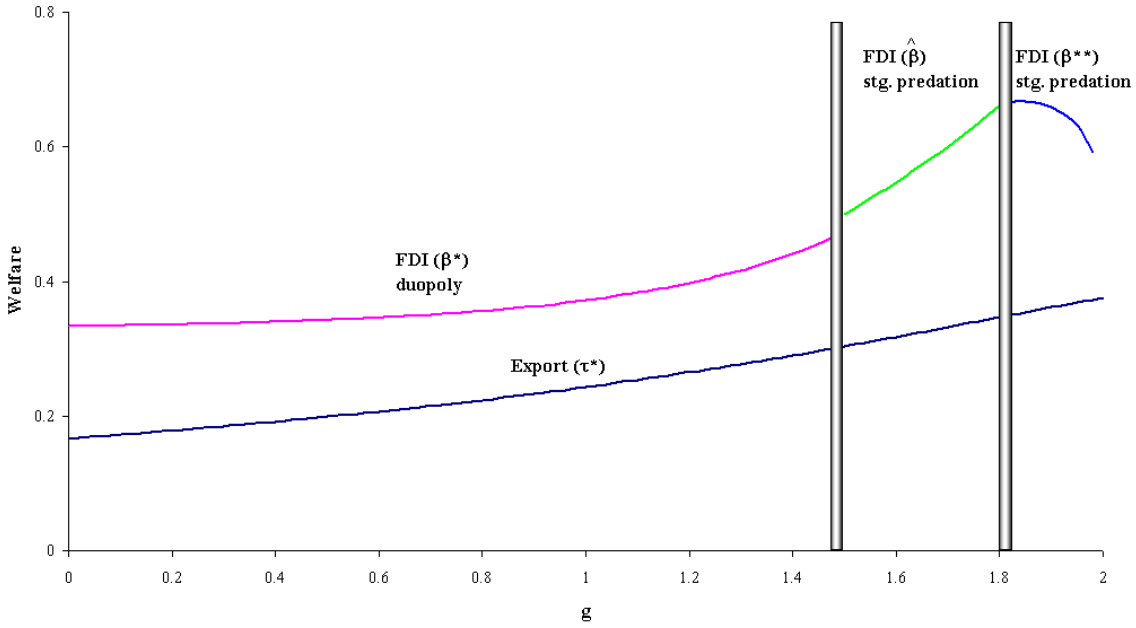


Figure 3: Southern Welfare



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